called. But, on the other hand, his reply reveals the fact that the educational authorities of the War Office still fail to see that science studies, like all other studies, must, in the case of the young, be somewhat prolonged in order to properly develop their value and render their effects permanent; especially if only a moderate portion of time can be devoted to them. For he stated that so far no cadet has gained admission to the Engineers without a fair knowledge of chemistry and physics. Now, as a good many of the cadets enter upon their work at Woolwich with little or no knowledge of these branches of science, as ten subjects are studied at the Royal Military Academy, and as the whole course of work only covers two years, it seems clear that the elementary knowledge in question must often be of a very elementary character indeed, however excellent the teaching may be, especially when it is remembered that some of the cadets doubtless have but little taste for such studies, and that the scientific faculties of these will have become more or less weakened by disuse during their previous course of training, which frequently has included no experimental science subject for several years.

The following are the circumstances of the case. The course of instruction at Woolwich occupies two years, which are divided into four terms. At the end of the second term, the choice of joining the Engineer Division is offered to the candidates in order of merit as indicated by the marks obtained in the first two terms. But no cadet can be posted to the Engineer Division who does not obtain 50 per cent. in fortification.

The marks for the obligatory subjects are:—

Mathematics[1]	3000
Fortification	2000
Military Topography	2000
French *or* German	1000
Chemistry and Physics	1000
Model Drawing	300

In addition, each cadet may take up a second modern language as a *voluntary subject* (in practice this is usually German), marks 1000—50 per cent. being the counting minimum; and landscape drawing is also a voluntary subject, marks 700, and counting minimum 50 per cent.

To count marks in any of the obligatory subjects, at least 25 per cent. of the total must be obtained.

For class promotion at the end of the first and second terms, candidates are required to obtain 50 per cent. of the marks in mathematics, and in at least three out of five obligatory subjects, and 50 per cent. of the aggregate.

Thus it appears that a candidate who had learnt no science at school might gain admission to the Royal Engineers in spite of failing in science at Woolwich.

Experience of this system as it works at the Royal Military Academy shows that in consequence of the very low minimum counting mark of science, even a beginner must be very dull or very idle to prevent him from counting the subject, especially as the teaching is suitable for beginners. Consequently, though chemistry and physics are nominally compulsory, anything beyond a very slight degree of proficiency is really a voluntary matter, especially as the effect of low marks in them can be compensated by marks obtained for a voluntary modern language by those who have offered two modern languages at entrance. The converse of this is not possible. For the voluntary modern language, in consequence of its high counting minimum mark, and in the absence of any really elementary teaching of the subject at the Royal Military Academy, cannot be made to count, as a rule, in the very limited time available, by those who have not taken it as one of their subjects at the entrance examination.

The result is that at the end of the second term those cadets who have taken two modern languages at the entrance competition may not only score a high mark for a voluntary language, but can also easily gain a helpful mark in science; whilst those who have taken up one modern language, and a branch of science, can only as a rule count marks in one subject at the later stage. As the competition for Engineers is very keen, the latter class are at a serious disadvantage. In short, the taking up of a second modern language at the entrance examination is made almost compulsory by the present system, much to the loss of those candidates whose abilities are greater in other subjects.

The state of things which we have endeavoured to make clear in a few words has only lately been realized by schoolmasters and parents, through the reports of former pupils and others who are familiar with the matter. The result has been that there is now often great pressure upon teachers to send up candidates with two modern languages, and no science for the entrance examination, even when they believe that to take up one modern language, and a branch of science would give the boy an equally good or better chance of gaining admission into Woolwich, and would be of far greater professional value to him afterwards. It is therefore certain that, unless it be shown that these views are wrong, or the conditions are amended, there will soon be a distinct diminution in the proportion of candidates offering science from the public schools.

The present situation is unfair to candidates whose abilities lie in the direction of science. It tends to keep out of the scientific branch of the Army the specially scientific candidates. It will tend, also, to keep boys from public schools out of the Army, and replace them by those who have resorted to Continental tutors. And finally, by discouraging the teaching of science in Army classes, it must make it increasingly difficult to maintain a high level of science work at schools generally. We therefore hope that those who are with us in this matter will take any steps they may be able, to secure that the opportunity created by Sir Henry Roscoe shall not be lost.

THE LATE SIR WILLIAM BOWMAN.

To many of the readers of Nature the distinguished man of science whose life was so unexpectedly brought to an end a little more than a fortnight ago, was best known as a great ophthalmic surgeon who for a long period of years occupied the first rank in his own line of professional work. But to those of us who are old enough to remember what physiology and anatomy were forty years ago, the name of Bowman has very different associations. It recalls to us a series of splendid anatomical discoveries communicated to the Royal Society between 1840 and 1850, of which the chief results were afterwards brought together in the great work which Bowman subsequently published in association with Dr. Todd on the "Physiological Anatomy of Man." In the following paragraphs I have endeavoured to give a sketch of the most important of these discoveries, in the hope that the many scientific friends to whom his memory is dear may find it, however imperfect, yet acceptable for his sake.

The three most important subjects of Bowman's researches were: (1) the structure of muscular fibre, (2) the structure of the kidney, and (3) that of the mucous membrane of the alimentary canal.

(1) *The Structure of the Fasciculus of Striated Muscle* (Phil. Trans., 1840).—It had been recognized that the fasciculus of striped muscle is made up of what Fontana designated as "*fils charnus primitifs*"; and much more recently

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[1] 800 additional marks for higher mathematics, but cadets cannot count these papers if they do not obtain at least 40 per cent. of the marks.

Schwann had shown that the muscular substance is inclosed in a sheath of structureless membrane, which he described as produced by coalescence of the cylindrical cells from which it had originated. Bowman was the first to observe that the "sarcous substance," as he called it, *i.e.* the organized content of this tubular sheath, is capable of being split, not only longitudinally into fibrils, but also into disks, and founded on this observation a new view of its structure—namely, that the sarcous substance consists of *cylindrical parts* ("sarcous elements"), each of which is a segment of a fibril. Bowman's observations were confirmed by Kölliker in the admirable account of the structure of muscle given in the first edition of the "Gewebelehre," published in 1850. He, however, still regarded the existence of "sarcous elements" as open to question. A few years later they acquired a new title to recognition when Brücke, in his researches on the structure of muscle with the aid of polarized light, discovered that the sarcous substance, as observed by this method, behaves as if it were made up of "a system of cylindrical bodies, each having the properties of uniaxial crystals with their axes parallel to that of the fasciculus." Brücke did not pledge himself to the identity of these cylindrical bodies (which he called "disdiaklasts") with Bowman's "elements," but rather regarded each such element as a system of disdiaklasts. It would occupy too much space to enter on this subject further. It must suffice to say that the relation between the optical properties of sarcous substance and its microscopical characters was soon fully recognized, and that Bowman's sarcous elements still hold their own in every discussion on the structure of muscle.

(2) *The Structure of the Mucous Membranes of the Alimentary Tract.*—On this subject Bowman's investigations were fundamental. If anyone were disposed to doubt their claim to have been the starting-point of the long series of researches by which our present knowledge of the subject has been attained, he might at once satisfy himself by comparing the clear account of the subject contained in Bowman's article in the "Cyclopædia of Anatomy" (1843) with the vague statements which are to be found in the best work on "General Anatomy" then in existence, Henle's "Allgemeine Anatomie," published immediately before. The contrast is striking. Within the compass of a very few years Bowman had succeeded in unravelling the structure of mucous membrane, and arriving at new conceptions of the relations between its constituent parts, which have survived to the present day, notwithstanding the infinite amount of work which has been done since, in the same field of inquiry—an achievement which appears the more worthy of admiration when it is remembered that Bowman began as it were from nothing, and had to rely on his own ingenuity for devising his methods, and on his own dexterity for carrying them out. For at that time and for many years after, the methods of preparing tissues so as to display their structure, which are now in everyone's hands, were practically unknown.

The Structure of the Kidneys.—The great discovery which was announced in Bowman's paper on the structure and use of the Malpighian bodies of the kidneys (Phil. Trans., 1842) was that of the connection between the Müllerian capsule and the uriniferous tubes. The anatomists of the time were unanimous in denying the existence of any such communication, and Müller himself—who, in his great work on the intimate structure of the secreting glands, published in 1830, gave the first account of the capsule—characterized the suggestion that it might be connected with the ends of the uriniferous tubes as a "*falsissima opinio.*" In the edition of the "Handbuch der Physiologie," however, which immediately followed the appearance of Bowman's paper, the great physiologist frankly admitted his error.

The result next in importance of Bowman's research was the explanation it enabled him to give of the renal circulation. The knowledge which existed was extremely defective. For, although it was known that there was a communication between the capillaries of the glomeruli and those of the convoluted tubes, the belief that the capsules were closed sacs rendered it impossible to understand their relation to the renal function. They were indeed regarded merely as *retia mirabilia*, intended to check the impetuous blood-stream in its course towards the tubes. Müller had, two years before the publication of Bowman's paper, recognized that the renal tufts of *Myxine* are contained in the urinary utriculi, but the identity of these structures with the glomeruli of the higher Vertebrates was overlooked by him until Bowman's description served to explain his own observations on the renal organs of the lower.

The theory of the function of the kidney which sprang out of Bowman's anatomical investigations was shortly as follows:—The epithelium which lines the convoluted tubes is the mechanism by which the characteristic constituents of the urine are excreted. The water of the urine is discharged by the Malpighian tufts by a process partly physical, partly vital. These organs thereby serve as an apparatus for the regulation of the water-content of the blood, and thereby of the whole body. The grounds for the theory were (1) the distribution of the capillary blood-vessels on the external surface of the tubes; (2) the analogy of the renal epithelium with that of other secreting glands; (3) the absence of any such epithelium on the surface of the tufts; and (4) the consideration that, by the arrangement of their capillaries, the blood-stream through the tufts is retarded—a circumstance favourable to filtration. The theory was in so far "vitalistic" that it assumed for the secreting epithelium a special power or endowment, of which its structure afforded no physical explanation. It was soon met by another which regarded the whole process mechanically. Only two years after Bowman's second paper, Ludwig's article in Wagner's "Handwörterbuch" appeared, in which it was maintained that not only water but the salts and other soluble constituents of the urine are discharged by a process of filtration, and that the function of the convoluted tubes of the cortex is not to secrete the solids of the urine, but to reabsorb the water, and thereby concentrate the product. Without entering into details, it may be sufficient to say that the theory of Ludwig was chiefly based on experimental evidence relating to the immediate influence of purely mechanical conditions in determining the rate of secretion, which showed that the renal flow is instantly increased by augmentation and diminished by decline of the difference between the arterial and venous pressures, and consequently varies with the rapidity of the renal blood-stream. For twenty years this theory was tacitly accepted, until in 1875 Heidenhain published the first of those researches on the process of renal secretion which form the basis of our present knowledge, and which resulted in the reinstatement of the doctrine of Bowman that in the kidney, as in other glands, secretion depends on the active function of special secreting cells. The most material *difference* between the doctrine now taught as the outcome of the anatomical and experimental researches of the last two decades, is connected with a fact which remained unknown for many years after the completion of Bowman's work—that the glomeruli or Malpighian tufts are provided with epithelium, and that their function is not, as Bowman thought, merely filtration. The essential point of *agreement* is that the living epithelial cell contains in itself the essential mechanism for secretion, and that it is on it that the influence of all external conditions is primarily exercised.

In the fifty years which have elapsed since Bowman arrived at a true conception of the function of the kidneys, an enormous and wholly unprecedented progress has been made in anatomical and physiological knowledge. The inferences to which he was chiefly guided by anatomical considerations have thus been placed on a wider basis, at the same time that they have been brought into complete harmony with the more certain evidence of experiment.

The above ragmentary account of Sir William Bowman's scientific work may suffice to show how much his early achievements aided the advancement of knowledge, and how materially they influenced the work of the other great anatomists and physiologists of that stirring time. Who can say how much more a man of such power would have contributed to the building up of the great science which in the vigour of youth he cultivated with such extraordinary success, had not external circumstances withdrawn him—too early—from its service?

J. Burdon Sanderson.

NOTES.

The new London County Council seems to have rather more enlightened ideas as to the need for the promotion of technical education than its predecessor. On Tuesday, when it was moved that the recommendation of the Finance Committee with regard to the Council's receipts and expenses for the year ending March 31, 1893, should be adopted, Mr. Quintin Hogg proposed as an amendment that the following words be added to the motion:—"Provided that £30,000, being part of the amount receivable by the Council for the financial year ending March 31, 1893, under the Local Taxation (Customs and Excise Duties) Act, 1890, be carried over to a suspense account, instead of being applied in reduction of rate, and that such £30,000, when carried over, be dealt with on or before October 1 next by the Council for any purpose authorized by the above Act; and that a special committee be appointed to consider what action the Council should take under the Technical Education Acts, 1889–91, and the Local Taxation (Customs and Excise Duties) Act, 1890, with power to draw up a scheme or schemes for the consideration of the Council." This was seconded by Mr. Baum, and warmly supported by Sir John Lubbock and other speakers. The amendment was adopted by a large majority, only three voting against it.

Dr. Scott having accepted the charge of the Jodrell Laboratory at Kew, the Assistant-Professorship in Botany at the Royal College of Science at South Kensington will be vacant at the end of the present session. The appointment rests with the Lord President of the Council, and candidates for the post should send their applications to the Secretary, Science and Art Department, accompanied by testimonials. The salary is £400 per annum.

Sir Andrew Clark, F.R.S., has been elected for the fifth time President of the Royal College of Physicians of London.

Mr. Francis Darwin, F.R.S., author of "The Life and Letters of Charles Darwin," has been elected a member of the Athenæum Club, under the terms of the rule which provides for "the annual introduction of a certain number of persons of distinguished eminence in science, literature, or the arts, or for public services."

The Trustees of the British Museum have appointed Mr. Arthur Smith Woodward to the Assistant-Keepership of the Department of Geology in succession to Mr. Etheridge, who has been retired by the operation of the Order in Council of August 1890. A junior assistantship which thus becomes vacant will shortly be filled by competition among the candidates nominated by the principal Trustees.

Mr. F. J. M. Page has been appointed to the Chair of Chemistry and Physics at the London Hospital rendered vacant by the death of Dr. Tidy.

Dr. Hugh Robert Mill has been appointed to succeed Mr. J. S. Keltie as Librarian to the Royal Geographica Society.

We have already announced that the Royal Medals of the Royal Geographical Society have been awarded to Mr. A. R. Wallace and Mr. E. Whymper. The Murchison grant has been awarded tc Mr. Swan (who accompanied Mr. Theodore Bent in his expedition to Mashonaland); the Back grant to the Rev. James Sibree for his many years' work on the geography and bibliography of Madagascar; the Cuthbert Peck grant to Mr. Campbell for his important journeys in Korea; and the Gill Memorial to Mr. Garrett for his geographical work during the past fifteen years in Sierra Leone.

At the meeting of the Royal Geographical Society, on Monday, Mr. Ernest Gedge read a paper on a recent Expedition under Captain F. G. Dundas, R.N., up the River Tana to Mount Kenia, in East Africa. He said that his account of the expedition had been compiled from the notes and jonrnals of the European members thereof. In appearance the Tana might be likened to a miniature Nile for the whole of its navigable length, a distance of some 360 miles by river, flowing through a vast plain, and generally confined between low banks. The surrounding districts were flooded during the rise of the river in the rainy season. In fact, the whole country from Charra across to the Ozi River might be described as one vast swamp choked with rank vegetation. Only a small fraction of this area was cultivated at present. Above Hameyé, the river was a succession of rapids and falls; the channel was choked with boulders, and quite unnavigable. In fact, it had the general appearance of a mountain torrent of large dimensions. With regard to the geological structure on the upper reaches, this appeared to consist principally of gneissic formations above Hameyé, which, on nearing Mount Kenia, gradually changed to indurated hornblendic schists, till on the mountain itself it again changed to basaltic rocks and volcanic ash.

Dr. Henry Hicks, F.R.S., has announced in the *Times* that during some recent excavations in Endsleigh Street, N.W., in connection with the deepening of the main sewer, the workmen came upon the remains of a mammoth and other prehistoric animals at a depth of about 22 feet from the surface. In the central excavation, near the north end of the street, two large tusks of a mammoth were met with lying near together along with other bones belonging to the same animal. A portion of one of these tusks was brought to the surface, and it was found to measure at its thickest part nearly 2 feet in circumference. The length of the complete tusks would probably be at least 9 feet or 10 feet. In another excavation on the west side of the street, at a distance of about 15 feet from the above-mentioned, the lower jaw and other bones of a younger mammoth were discovered at about the same depth from the surface. The dark loamy soil in which the remains were embedded has yielded on examination many seeds of contemporary plants; and Mr. Clement Reid, of the Geological Survey, to whom samples of the loam were submitted, has been able to determine the presence in it of about twenty species. These show that the land at the time was of a marshy nature. Deposits usually classed with the high-level gravel and brick earth of the Thames Valley were found overlying the animal remains; hence the geological age during which the animals lived, in Dr. Hicks's opinion, must be included in what is known as the Glacial period.

A bust of Gustav Nachtigal has been set up in the Berlin Museum für Völkerkunde, beside the collections formed in the